

# INDOOR AIR QUALITY ASSESSMENT

**Lowell Juvenile Court  
291 Summer Street  
Lowell, Massachusetts**



Prepared by:  
Massachusetts Department of Public Health  
Bureau of Environmental Health Assessment  
July, 2001

## **Background/Introduction**

In response to a request from the Honorable Joseph Trainor, Presiding Judge, a visit was conducted to assess the indoor air quality at the Lowell Juvenile Court (LJC). This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Complaints of eye, throat and respiratory irritations prompted the request. On March 29, 2001 the LJC was visited by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) program.

The LJC resides in a one-story, graded-slab, brick building, which formerly housed the Department of Employment and Training (DET). The DET leases the space to the LJC (see Picture 1). The LJC consists of a large open area separated into workstations by cloth-covered floor dividers approximately four feet tall. In the rear of the building are a breakroom, the judge's lobby, restrooms, meeting room and a courtroom. The basement is unoccupied and contains an above ground fuel tank and oil burner. It was reported that the LJC will relocate to a new facility by June of 2001. The current space is tentatively scheduled to be occupied by Middlesex County Sheriffs Department when the LJC moves.

## **Methods**

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

## **Results**

The building has a population of approximately 25 employees and an estimated 10-15 other individuals who visit the building on a daily basis. The tests were taken under normal operating conditions. Test results appear in Tables 1-2. Air sampling results are listed in the tables by the location that the air sample was taken.

## **Discussion**

### **Ventilation**

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air [ppm] in seven of twelve areas sampled, which is indicative of inadequate fresh air supply in these areas. A heating, ventilation and air conditioning (HVAC) system provides ventilation. Fresh air is provided by two rooftop-mounted air-handling units (AHUs) (see Picture 2). Air is distributed by ducted, ceiling vents located throughout the building (see Picture 3). The LJC is divided into two HVAC zones divided in the center of the building. The zones are each controlled by thermostats (see Picture 4). These types of thermostats usually have settings of “on” and “automatic” and are typically set to the “automatic” setting. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once a preset temperature is reached by the thermostat, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system. The system was not operating during the assessment, which indicates that it was in the off-cycle or deactivated. Several air diffusers were sealed with plastic sheeting and/or cardboard (see Picture 5 & 6). Occupants stated that these diffusers have been obstructed since the LJC occupied the

building (approximately 2 years ago). Alterations of the system such as these can interfere with proper airflow and balancing, resulting in the creation of uneven heating/cooling conditions in other areas.

Exhaust ventilation is provided by three passive, non-mechanical rooftop vents (see Picture 7). This type of ventilation system relies on positive pressure created by the HVAC system to force air out the passive exhaust vents. As rooftop AHUs operate, air pressure increases as additional fresh air is introduced to pressurize the interior of the building (called positive pressure). As positive pressure increases, air is forced out through openings in the ceiling (see Picture 8) and out the rooftop exhaust vents. The design of the vents requires that exterior doors and windows remain closed to the extent practical in order to maintain positive pressure. Reports of drafts and occasional precipitation from these passive vents were reported by building occupants. Without a mechanical system, these vents may not function adequately to provide exhaust ventilation and be a source of cold air during winter months. In order to have vents operate as designed, doors and windows must remain closed.

In order to have a properly functioning mechanical ventilation system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last servicing and balancing of the HVAC systems was not available at the time of the visit. Reportedly, the system is maintained by an HVAC engineering firm (Honeywell, Inc.) under contract to the DET. It is

recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated

temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperatures ranged from 68° F to 76° F, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Although the temperature in a number of areas measured on the day of the assessment were within BEHA comfort guidelines, occupants expressed a number of complaints of uneven heating and cooling. As mentioned previously, diffusers distributing air to workstations throughout the space were obstructed, which can prevent proper airflow and circulation and subsequently lead to comfort complaints.

The relative humidity in the building ranged from 23 to 28 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the LJC would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

### **Microbial/Moisture Concerns**

Several areas contained water-stained ceiling tiles (see Picture 9), which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of microbial growth and should be replaced after a water leak is repaired.

Flooring of the LJC is covered throughout with square carpet tiles. Water stains were noted on carpeting in front of the exterior door that exits to the side parking lot (see Picture 10). The most likely source of water is through spaces around the exterior door.

The break room had a water cooler installed over carpeting (see Picture 11). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur.

Caulking around window frames was in a crumbling/damaged condition (see Pictures 12 & 13). Efflorescence (i.e., mineral deposits) and peeling paint were observed on the interior walls of the building around windows (see Picture 14). Efflorescence is a characteristic sign of water intrusion. As moisture penetrates and works its way through mortar around brick and other building materials (e.g., plaster, wallboard) it leaves behind these characteristic mineral deposits. This condition indicates that water from the exterior is penetrating into the building. In addition, several windowpanes were also broken. Water penetration through broken windowpanes and frames can lead to mold growth under certain conditions. Replacement of broken windows and repairs of window leaks are necessary to prevent further water penetration.

Also noted along the perimeter of the building were trees/stumps and other plants growing in the tarmac/exterior wall junction (see Picture 15). The growth of roots against the exterior walls of the building can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. This problem can serve to breach the integrity of the building envelope and therefore could serve as a source of water penetration.

BEHA staff opened an AHU access panel and noted residue from what appeared to be pooling water (see Picture 16). The water stains on the interior of the unit can indicate: 1) that the panels were not fastened securely, 2) that the watertight integrity of the unit has been breached, or 3) that condensation is building up inside the unit. If the integrity of the case is breached, uncontrollable amounts of outdoor air, humidity and moisture can penetrate into the AHU, resulting in damage to machinery and creating conditions conducive to mold growth.

Pooling water was observed on the roof (see Picture 17). The freezing and thawing of water during winter months can lead to roof leaks and subsequent water penetration into the interior of the building. In addition, stagnant pools of water can serve as a breeding ground for mosquitoes.

### **Other Concerns**

Located in the basement is the fuel tank and oil burner. A petroleum odor was noted in the basement. The most likely source appeared to be an open container of oil found on the floor against the basement wall (see Picture 18). Spaces were noted around



the door to the basement stairwell, which can provide a means of egress for odors, fumes, dusts and vapors between the basement and occupied areas of the LJC.

As mentioned previously, the LJC floor is covered with carpet squares. Carpet can act as a reservoir for tracked-in dust and dirt and can become re-aerosolized as a result of foot traffic. In a number of areas in the building, carpet appeared soiled with accumulated dirt and debris. Dust can be irritating to the eyes, nose and respiratory tract.

## **Conclusions/Recommendations**

In view of the findings at the time of the visit, the following recommendations are made:

1. To maximize air exchange, the BEHA recommends that the ventilation system operate to continuously supply fresh air during business hours. Contact HVAC maintenance representative (Honeywell, Inc.) to determine if thermostats can be set to operate the HVAC system continuously during periods of occupancy.
2. Inspect rooftop AHUs to ensure fresh air intake louvers are operable. Change filters for AHU equipment as per the manufacturer's instructions or more frequently if needed. Examine AHUs periodically for maintenance and function, repair/replace parts as necessary.
3. Consider having the mechanical fresh air supply and exhaust balanced by an HVAC engineer. Increase the percentage of fresh air if necessary.
4. Remove all blockages from air diffusers to ensure adequate airflow.
5. Examine the feasibility of providing mechanical exhaust ventilation.

6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Remove tree and/or plant growths against the building.
8. Repair any existing water leaks and replace any water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
9. Report any roof leaks or other signs of water penetration to building owner/manager for prompt remediation.
10. Seal exterior door to side parking lot with weather-stripping to prevent water penetration and subsequent water damage to carpeting.
11. Consider having exterior brick repointed and waterproofed to prevent further water intrusion. Repair/replace water damaged plaster. Examine surrounding non-porous areas for mold growth and disinfect with an appropriate antimicrobial if necessary.
12. Repair/replace loose/broken windowpanes and missing or damaged window caulking building-wide to prevent water penetration through window frames.

13. Place rubber/plastic matting beneath water cooler to prevent water damage to carpeting.
14. Remove container of oil in basement, empty containers of hazardous materials in a manner consistent with environmental statutes and regulations.
15. Increase/improve carpet cleaning.

## **References**

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8<sup>th</sup> ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

**Picture 1**



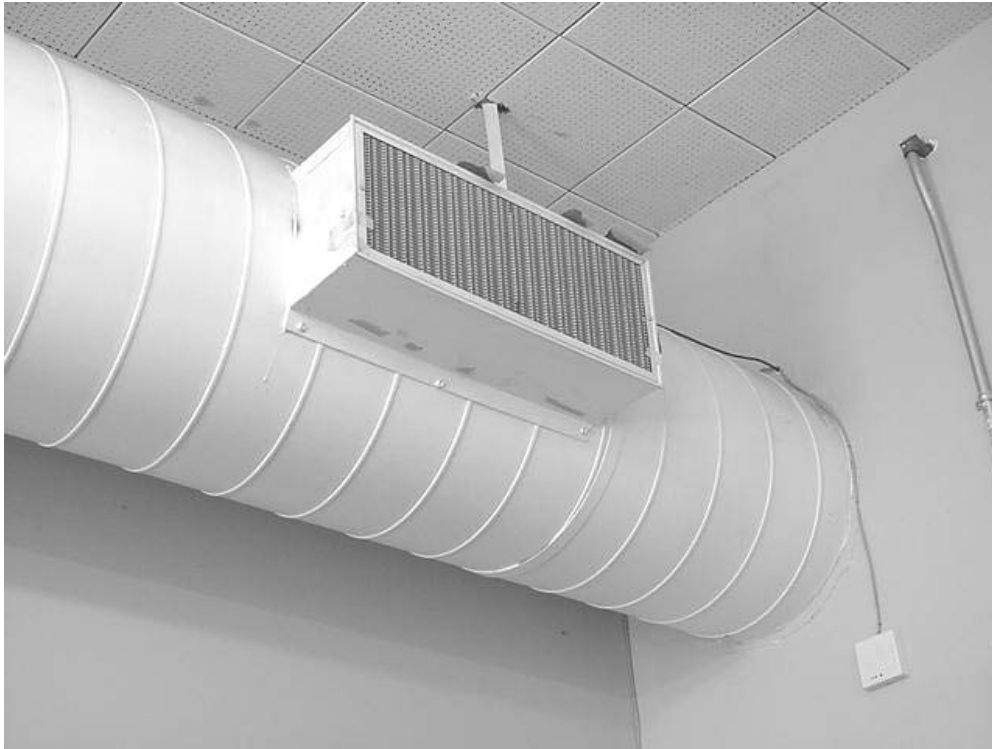
**Lowell Juvenile Court, 291 Summer Street, Lowell, MA**

**Picture 2**



**One of Two Rooftop AHUs**

**Picture 3**



**Fresh Air Diffuser**

Picture 4



Thermostat Controlling HVAC System



**Picture 5**



**Fresh Air Diffuser Sealed With Plastic Sheeting**

**Picture 6**



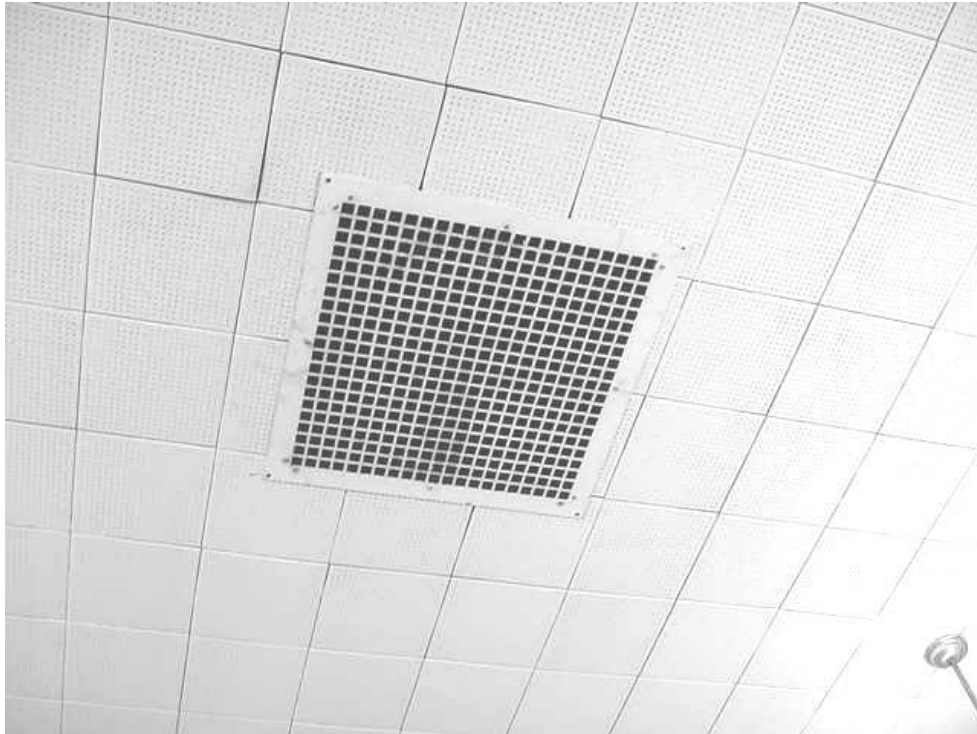
**Fresh Air Diffuser Obstructed by Cardboard**

**Picture 7**



**Passive Rooftop Exhaust Vent (One of Three)**

**Picture 8**



**Passive Exhaust Grill**

**Picture 9**



**Water-Damaged Ceiling Tiles**

**Picture 10**



**Water-Damaged Carpeting Near Exterior Door to Side Parking Lot**

**Picture 11**



**Water Cooler on Carpet**

**Picture 12**



**Missing/Damaged Exterior Window Caulking**



**Picture 13**



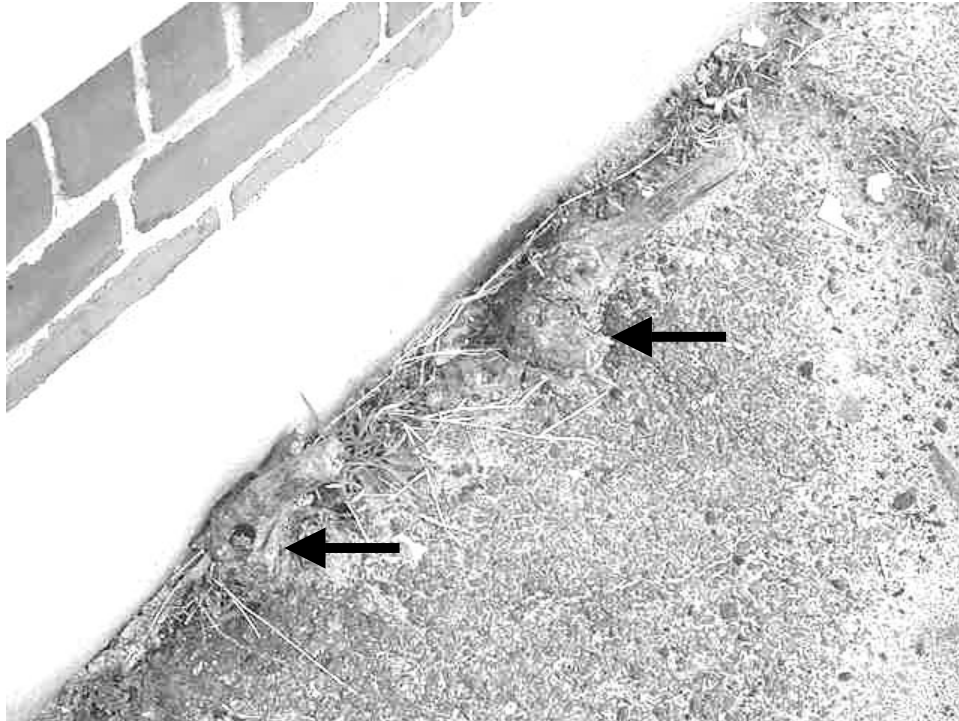
**Spaces around Exterior Window Frames**

**Picture 14**



**Water-Damage/Peeling Paint on Interior Wall**

**Picture 15**



**Plant Growth along Exterior Wall/Tarmac Arrows Indicate Small Tree Stumps**

**Picture 16**



**Water Stains inside AHU**

**Picture 17**



**Pooling Water on Roof, Note Roof Drain**

**Picture 18**



**Open Container of Oil in Basement**

TABLE 1

**Indoor Air Test Results – Juvenile Court, Lowell, MA – March 29, 2001**

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	422	57	29					Weather conditions: cloudy, breezy
NW Corner	759	68	28	1	Yes			Water damaged carpet-exterior door
Restrooms					Yes	No	No	No mechanical exhaust
Judge's Lobby- Cubicle Area	819	76	23	2	No	Yes	Yes	*center room, thermostat against N wall
Court Room	810	75	23	0	Yes	Yes	Yes	Passive exhaust vent, 14 water damaged CT
Meeting Room	791	74	23	0	Yes	Yes	Yes	Passive exhaust vent, thermostat, 36 water damaged CT
Court Clinic	817	75	23	4	Yes	Yes	No	Numerous water damaged CT, water damaged wall plaster/peeling paint around windows
Law Clerk's Area	809	74	23	1	Yes	Yes		Broken window
Reception Area	812	75	23	3	No	Yes	Yes	Center of room
Computer Terminal Area	796	75	23	0	Yes	Yes	No	Former DET area-not used by juv. Court staff

\* ppm = parts per million parts of air  
CT = ceiling tiles

**Comfort Guidelines**

Carbon Dioxide - < 600 ppm = preferred  
600 - 800 ppm = acceptable  
> 800 ppm = indicative of ventilation problems  
Temperature - 70 - 78 °F  
Relative Humidity - 40 - 60%

TABLE 2

**Indoor Air Test Results – Juvenile Court, Lowell, MA – March 29, 2001**

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
ACPO	790	75	23	0	Yes	Yes	Yes	Supply vent sealed with trash bag
CPO	800	75	23	1	No	Yes	Yes	Supply vent sealed with trash bags
Break Room	926	75	24	1	Yes	Yes	Yes	Passive exhaust vent
Basement				0	No	No	No	Above ground oil tank, oil burner, water heater, open container of waste oil, spaces around door, slight fuel odors
Judge's Office	898	75	25	3	Yes	Yes	Yes	Passive exhaust vent, active leak reported, water cooler on carpet
Roof Notes					3 natural gravity exhaust vents, 2 AHU (Trane), black rubber membrane roof, AHUs not operating during roof assessment-filters clean-minimal filtration, water stains-interior of AHU long seam, water pooling NW corner drain-raised drain lip (~1")			

\* ppm = parts per million parts of air  
CT = ceiling tiles

**Comfort Guidelines**

Carbon Dioxide - < 600 ppm = preferred  
600 - 800 ppm = acceptable  
> 800 ppm = indicative of ventilation problems  
Temperature - 70 - 78 °F  
Relative Humidity - 40 - 60%